# Use of evidence from studies of PM<sub>2.5</sub> and mortality in the Global Burden of Disease Comparative Risk Assessment

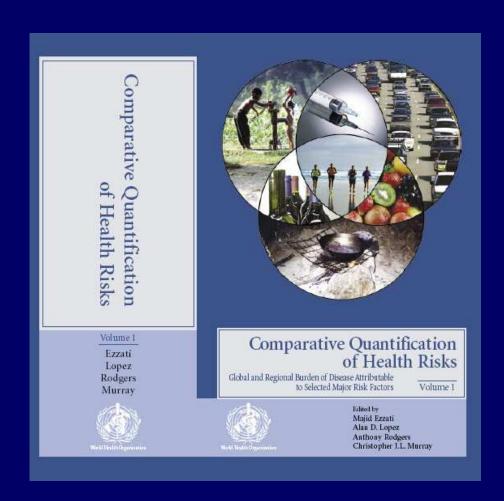
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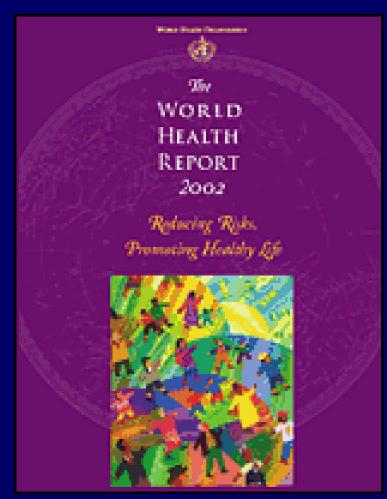
**Health Effects Institute** 

## What is the Global Burden of Disease Comparative Risk Assessment (GBD/CRA)?

- A collaborative effort of Gates-funded Institute for Health Metrics and Evaluation, WHO and leading academic centers
- Measure loss of health due to comprehensive set of disease, injury, and risk factor causes in a comparable way
- Quantify the role of >35 selected, potentiallymodifiable risk factors in global and regional burden of disease using comparable methods
- Produce disease, injury, and risk burden estimates for 1990 and 2005 using comparable methods for 21 regions which collectively span the global population

## CRA project and WHO's World Health Report 2002

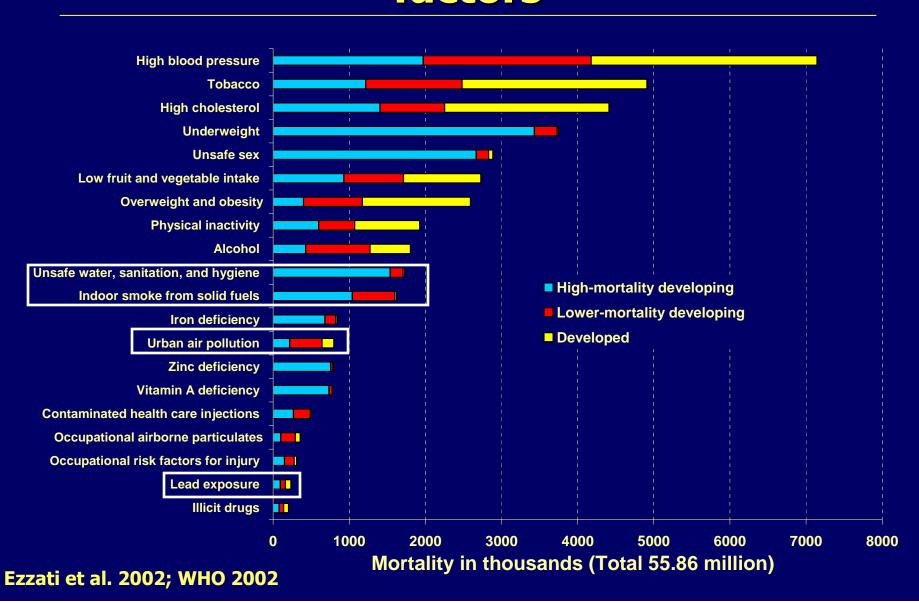




http://www.who.int/healthinfo/global\_burden\_disease/cra/en/index.html

http://www.who.int/whr/2002/en/

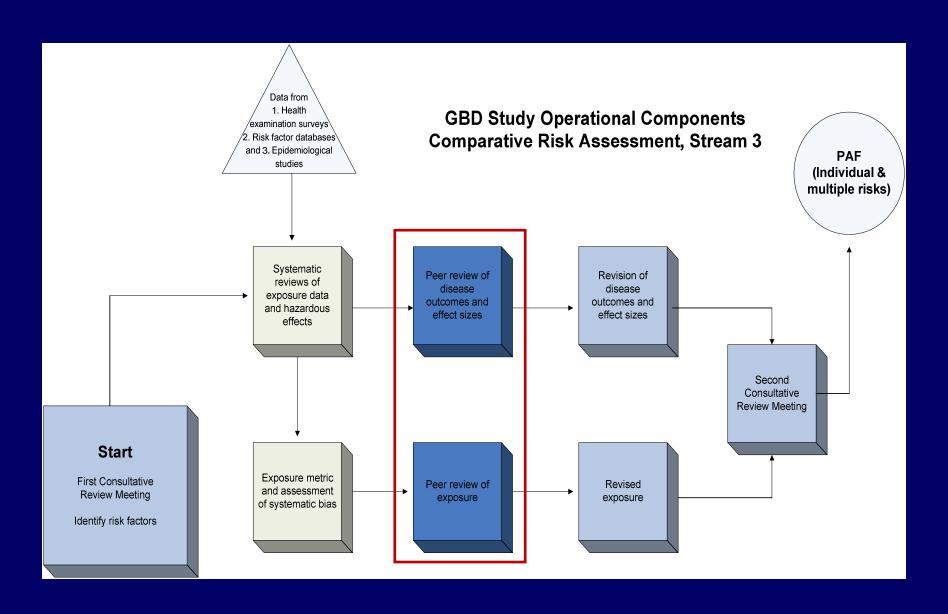
## Mortality attributable to leading risk factors



#### **Major Changes for GBD 2005**

- Estimate exposure for populations in cities
   <100,000 and rural areas</li>
- Use more extensive evidence to derive cause-specific risk estimates for chronic cardiovascular and respiratory disease in adults and children, other potentially important health outcomes, e.g. adverse reproductive outcomes

#### **GBD 2005 – CRA Process**



#### **Outdoor Air Pollution Expert Group**

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World Bank

Brigham Young U

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INSP/Mexico

**U Maryland** 

**UC Berkeley** 

**New York University** 

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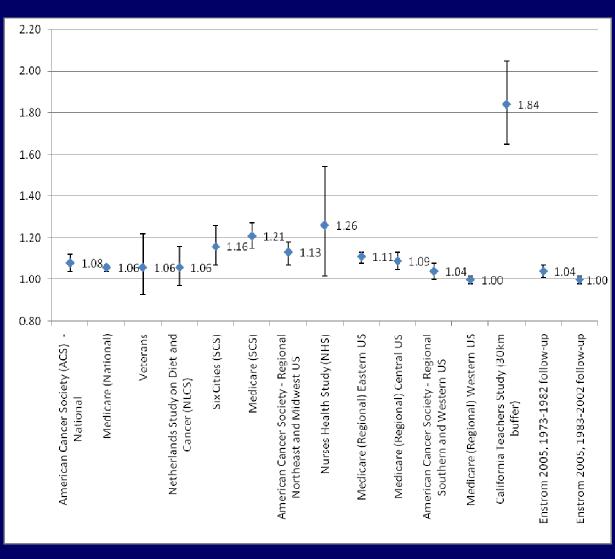
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## GBD Outdoor Air Estimates: an Overview

- Cause-specific, not all-cause, mortality
- Burden estimated as Disability Adjusted Life-Years (DALYs), the sum of Years Lived with Disability and Years of Life Lost, as well as numbers of deaths
- PM<sub>2.5</sub> estimated using two approaches: Satellite-derived estimates (MODIS/MISR) and Chemical transport model (GAINS/TM5)
- C-R functions must be derived for annual average levels of  $PM_{2.5}$  from 4->100  $\mu g/m^3$
- Overall uncertainty estimates will comprise uncertainties in estimates of baseline mortality, exposure, and C-R functions

#### **Expert Group Review of Adult Mortality Studies (1)**

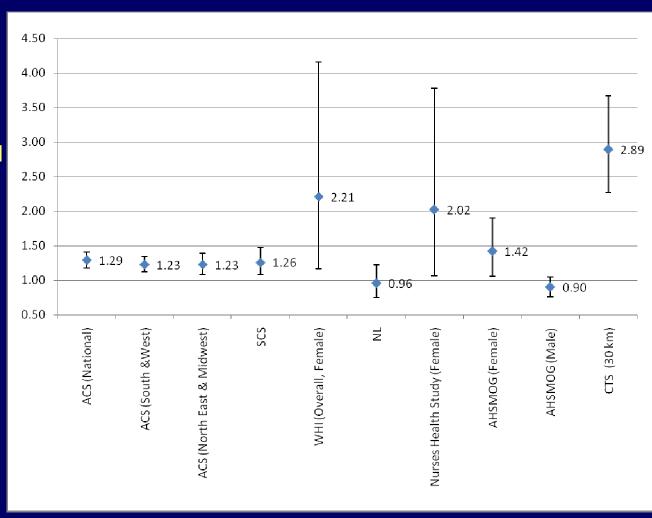
- Reviewed evidence for effects of longterm exposure to air pollution mortality, including recent comprehensive, systematic reviews by WHO, UK COMEAP and US EPA
- Reviewed all cohort studies of long-term exposure to air pollution and mortality published through 2009
- Focus on 9 cohort studies that have examined the association between long-term PM exposure and mortality



RR of death from all causes for a 10  $\mu$ g/m<sup>3</sup> change in PM<sub>2.5</sub> (95% confidence intervals)

#### **Expert Group Review of Adult Mortality Studies (2)**

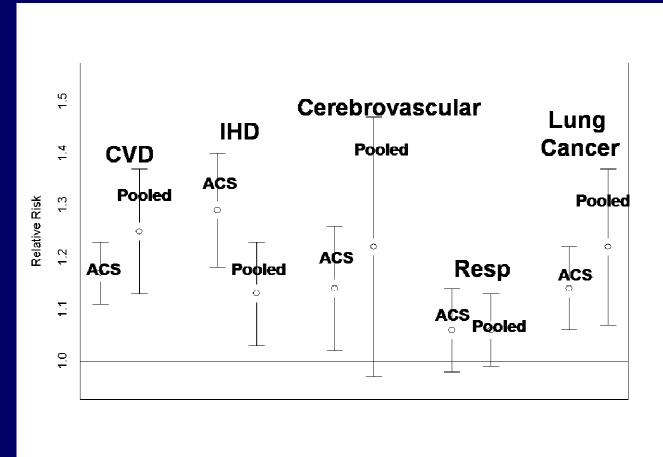
- **Evidence** is most consistent with a causal effect of longterm exposure on cardiovascular and respiratory disease and lung cancer, based on the lack of competing explanations (e.g., confounding or other bias), broad consistency with evidence from other, related, exposures and evidence of biologic mechanisms
- The shape of the PM<sub>2.5</sub> C-R functions appear linear from ~4-30 μg/m<sup>3</sup>
- The estimates from different cohort studies vary



RR of death from IHD for a 10  $\mu$ g/m³ change in PM<sub>2.5</sub> (95% confidence intervals)

### Methods for adult mortality: evidence base for C-R function estimates

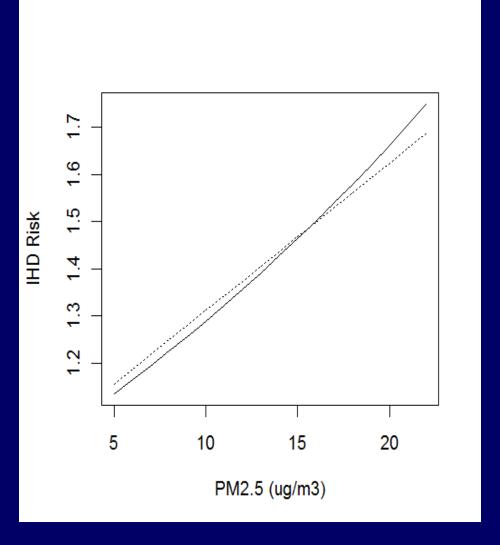
- 6 out of 9
   studies reported
   risks by selected
   causes of death
- 5 studies used measured PM<sub>2.5</sub> concentrations (ACS, SCS), others used PM<sub>10</sub> or PM<sub>10</sub> to PM<sub>2.5</sub> conversion
- ACS estimates are broadly consistent with cause-specific results from other studies, though appear higher for IHD



RR of cause-specific mortality for a 10  $\mu g/m^3$  change in PM<sub>2.5</sub> in ACS and other cohort studies (95% confidence intervals)

#### Methods for adult mortality: choice of C-R function

- C-R functions from American Cancer Society Study (HEI 2009) for IHD, cerebrovascular disease, respiratory disease and lung cancer mortality
  - Largest study
  - Extensively re-analyzed and critically reviewed
  - Extensive control for potential confounders
  - Direct measurements of PM<sub>2.5</sub>
  - Entire US comprising diverse sources of PM<sub>2.5</sub>
  - Cause-specific risk estimates
- Exposure from 1999-2000
- Several model forms explored. Little difference at low concentrations.
- Will use exponential (Cox PH) with PM<sub>2.5</sub> from 4-30 μg/m<sup>3</sup> as a linear term



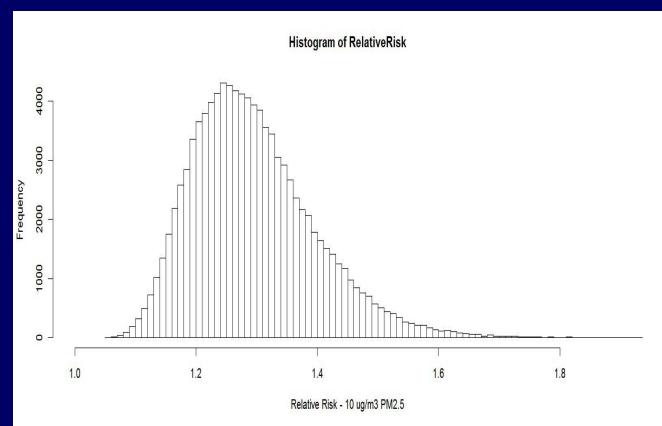
Exponential (solid line) and linear (dotted line) risk models for IHD deaths in the ACS study

## Methods for adult mortality: quantification of uncertainty

Uncertainty intervals for the C-R functions based on the variation in relative risk among all available cohort studies to capture several sources of uncertainty, e.g. differences in study populations, methods of exposure assessment, geographic variation in risk, and analysis strategy

 Modeled as a Gamma distribution: exposure never prevents death but may not cause it (i.e., RR >= 1.00)

 C-R function uncertainty will be one of 3 contributors to overall uncertainty along with baseline mortality and exposure



#### **Summary**

- Our systematic review supports a causal interpretation of the results of studies of longterm exposure to fine PM and mortality from chronic cardiovascular and respiratory disease
- These studies, including and specifically the most recent follow-up of the ACS cohort (Krewski et al. 2009), can be used to estimate the global burden of disease attributable to outdoor air pollution
- Uncertainty in estimates of the burden of disease attributable to outdoor air pollution needs to be quantified and should reflect the contribution of all important sources of uncertainty

## For more information on the Global Burden of Disease Comparative Risk Assessment:

http://www.globalburden.org/

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